IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 09/876,977
Filed: June 8, 2001
Inventor(s):
Lothar Wenzel Ram Rajagopal
and Dinesh Nair

Title: SYSTEM AND METHOD FOR GENERATING A LOW DISCREPANCY CURVE IN A REGION

Examiner: Caschera, Antonio A.
Group/Art Unit: 2676
Atty. Dkt. No: 5150-56900

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Jeffrey C. Hood

11/9/2004
Date

Signature

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Respectfully submitted,

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APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir/Madam:

Further to the Notice of Appeal filed October 7, 2004, Appellants present this Appeal Brief. Appellants respectfully request that this appeal be considered by the Board of Patent Appeals and Interferences.

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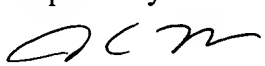
VIII. CONCLUSION

For the foregoing reasons, it is submitted that the Examiner's rejection of claims 1-3, 12, 23, 24, 31, 34, and 35 was erroneous, and reversal of his decision is respectfully requested.

The Commissioner is authorized to charge the appeal brief fee of $330.00 and any other fees that may be due to Meyertons, Hood, Kivlin, Kowert, & Goetzel, P.C. Deposit Account No. 501505/5150-56900/JCH. This Appeal Brief is submitted with a return receipt postcard.

Respectfully submitted,



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Date: November 9, 2004 JCH/MSW

I. REAL PARTY IN INTEREST

The subject application is owned by National Instruments Corporation, a corporation organized and existing under and by virtue of the laws of the State of Delaware, and having its principal place of business at 11500 N. MoPac Expressway, Bldg. B, Austin, Texas 78759-3504.

II. RELATED APPEALS AND INTERFERENCES

No other appeals, interferences or judicial proceedings are known which would be related to, directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 1-38 are pending. Claims 1-3, 12, 23, 24, 31, 34, and 35 are rejected, and are the subject of this appeal. Claims 4-11, 13-22, 25-30, 32, 33, and 36-38 are objected to. A copy of claims 1-3, 12, 23, 24, 31, 34, and 35 as on appeal is included in the Claims Appendix attached hereto.

IV. STATUS OF AMENDMEMNTS

No amendments to the claims have been submitted subsequent to the final rejection.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 is directed to a method for generating a curve in a region. An unbounded Low Discrepancy Point is generated, which may be inside or outside the region. *See, e.g.,* Specification p. 38, line 1 – p. 39, line 4; p. 49, lines 1-5; and Figure 12A at 1222. One or more boundary conditions are applied to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, where the bounded Low Discrepancy Point is located within the region. *See, e.g.,* Specification p. 49, lines

6-20; and Figure 12A at 1224. The generating and applying one or more boundary conditions are repeated one or more times, thereby generating a Low Discrepancy Sequence in the region. *See, e.g.,* Specification p. 49, lines 21-24; and Figure 12A at 1226, 1222, and 1224. The Low Discrepancy Sequence is stored. *See, e.g.,* Specification p. 49, lines 25-26; and Figure 12A at 1228. Output comprising the Low Discrepancy Sequence is generated, where the Low Discrepancy Sequence defines or represents the curve in the region. *See, e.g.,* Specification p. 50, lines 3-7; and Figure 12A at 1230.

Independent claim 23 is directed to a memory medium that stores program instructions executable to perform the method of claim 1, the subject matter of which is concisely summarized above.

Independent claim 34 is directed to a system that includes a CPU and a memory medium, where the memory medium stores one or more software programs executable by the CPU to perform the method of claim 1, the subject matter of which is concisely summarized above.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1-3, 12, 23, 24, 31, 34, and 35 are finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Davies et al. ("Low-Discrepancy Sequences for Volume Properties in Solid Modeling" CSG'98, 1998, hereinafter "Davies") in view of Ninomiya et al. (U.S. Patent 5,790,442, hereinafter "Ninomiya").

VII. ARGUMENT

First Ground of Rejection:

Claims 1-3, 12, 23, 24, 31, 34, and 35 are finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Davies et al. ("Low-Discrepancy Sequences for

Volume Properties in Solid Modeling" CSG'98, 1998, hereinafter "Davies") in view of Ninomiya et al. (U.S. Patent 5,790,442, hereinafter "Ninomiya"). Appellants traverse this rejection for the following reasons. Different groups of claims are addressed under their respective subheadings.

Claims 1, 23, and 34:

Appellants respectfully submit that each of claims 1, 23, and 34 recite combinations of features not taught or suggested in Davies and/or Ninomiya. More specifically, the cited art does not teach or suggest: "generating an unbounded Low Discrepancy Point, applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region, repeating said generating and said applying one or more boundary conditions one or more times, thereby generating a Low Discrepancy Sequence in the region, storing the Low Discrepancy Sequence, and generating output comprising the Low Discrepancy Sequence, wherein the Low Discrepancy Sequence defines the curve in the region," as recited in claim 1.

Davies is concerned with the computation or estimation of multi-dimensional volume integrals in geometric modeling using low-discrepancy sequences, where low-discrepancy point sequences replace random points in Monte Carlo methods. More specifically, Davies describes generating a low-discrepancy point sequence in a rectangular box, where the box encloses an object whose volume is to be determined. Each point is then tested to determine if it is inside the object or outside the object. Then, as Davies states on p. 1, "the volume of the object can be estimated as the ratio of number of points are contained within the object to the total number of points generated, multiplied by the volume of the box."

Appellant notes that there is an error in the Davies reference on page 6, just before equation (9), which reads:

> Each volume was calculated by generating points lying inside a rectangular box enclosing the object, using point-membership classification to decide if each point was

inside the ***box***, [*emphasis added*] and then using the formula:

$$V_{obj} = V_{box}(N_{in}/N) \qquad (9)$$

Clearly, since the generated points are by definition inside the box, the point-membership classification is to determine whether each point is also *inside the **object***, not the ***box***, otherwise, the volume of the object would always be computed simply as the volume of the enclosing box, with a constant ratio of "1", which is certainly not useful. Appellants note, however, that the arguments presented herein apply with equal force to either interpretation of Davies.

The Advisory Action asserts that Davies teaches all of the limitations of claim 1 except for storing the sequence, which is disclosed in Ninomiya. More specifically, the Advisory Action has equated Davies' determining whether points fall within the rectangular box (or object) with the limitation *applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region*, of claim 1. Appellant respectfully submits that this asserted equivalence is invalid. Appellant notes that applying the one or more boundary conditions to an unbounded low discrepancy point generates a bounded low discrepancy point. In other words, in the present invention as represented by claim 1, if the unbounded low discrepancy point is determined to be outside the region, then the point is moved *into* or re-located *inside* the region, i.e., the point is *bounded*, hence the term "bounded low discrepancy point", in claim 1.

In contrast, Davies discloses determining if a low discrepancy point is within the boundaries of a defined volume, but specifically does not apply boundary conditions to generate a "bounded low discrepancy point". In other words, if Davies determines that a low discrepancy point is outside the specified volume or region, the point remains in place, and no bounded point is produced, thus Davies does *not* teach *generating a bounded low discrepancy point* based on an unbounded low discrepancy point. Rather, Davies teaches classifying each point as either inside or outside the box (object), and simply comparing the number of those inside with the total number of points. Thus,

while Davies does generate low-discrepancy points, *all of the points are static*, i.e., no boundary conditions are *applied* to unbounded points to *generate* bounded points.

The Advisory Action also asserts that Davies' low-discrepancy sequences can be "understood as curvatures, located within the rectangular box, which makeup the object boundaries volume". Appellants respectfully disagree.

The Examiner's assertion of an equivalence between Davies' object boundaries and the curve defined or represented by the Low-Discrepancy Sequence of claim 1 is improper for several reasons. For example, Davies' object boundaries are in fact surfaces, not curves. Moreover, Davies' object boundaries are defined *a priori*, and are specifically *not* defined by Davies' low-discrepancy point sequence. In other words, Appellants' low discrepancy sequence of points is distinct from Davies' object boundaries in that Davies' object boundaries specify a geometric surface used to test for inclusion of low discrepancy points within the volume defined by the object boundaries, and are *not* the low discrepancy sequence itself. More specifically, Davies' object boundaries are not a sequence of bounded low discrepancy points as disclosed and claimed in the present application, but rather surfaces against which the points of the low-discrepancy sequence are tested to determine if each point lies inside or outside the object. Thus, Davies fails to teach or suggest these limitations of claim 1.

The Examiner cites Ninomiya in an attempt to overcome the deficiencies of Davies. Ninomiya discloses storing low discrepancy sequence components and expansions, but does not teach or suggest *applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region.* Thus, Ninomiya fails to overcome the deficiencies of Davies.

Additionally, Appellants respectfully submit that neither Davies nor Ninomiya provides a motivation to combine, and note that, as argued above, even if the references were properly combinable, the resulting combination does not teach Appellants' invention as represented in claim 1. Appellants submit that Davies describes generating the low-discrepancy point sequence via the well-known Sodor and Neiterreiter methods (favoring the more efficient and effective Neiterreiter method), and further note that

Davies' approach would not operate correctly if points outside the object boundaries were moved or repositioned inside the object boundaries via application of boundary conditions, since doing so would invalidate the use of the ratio of eq. (9) in determining the volume of the object. For example, if all the points outside the object boundaries were repositioned inside the object boundaries, then the ratio of points inside the object to those inside the box would always be equal to one, and so would not accomplish the stated objective of Davies. One of ordinary skill in the art would readily understand the differences between Davies point classification regarding points inside or outside the object boundaries, and claim 1's application of boundary conditions to unbounded points to generate bounded points. Thus, Appellants respectfully submit that not only does Davies *not* teach or suggest the limitations of claim 1, but Davies actually teaches away from Appellants' invention as claimed.

Ninomiya is concerned with the rapid computation of a low-discrepancy sequence, but accomplishes this via an entirely different approach than Appellants' invention as represented in claim 1. The Examiner appears to rely on Ninomiya only for the limitation of storing the low-discrepancy sequence. Appellants submit that the Examiner has simply selected particular portions of the cited references in an attempt to produce Appellants' claimed invention using claim 1 as a blueprint, which is improper. Furthermore, as explained above, even in combination the cited references fail to produce all the features and limitations as claim 1. Thus, Appellants respectfully submit that Ninomiya neither hints nor suggests the application of boundary conditions to generate bounded low-discrepancy points from unbounded low-discrepancy points, and thus fails to remedy the deficiencies of Davies. No combination of Davies and Ninomiya suggests anything about applying boundary conditions to unbounded low-discrepancy points to generate bounded low-discrepancy points.

Thus, Appellants respectfully submit that neither Davies nor Ninomiya, either singly or in combination, teaches or suggests all the features and limitations of claim 1, and so Appellants submit that claim 1 and those claims dependent thereon are patentably distinct and unobvious over Davies and Ninomiya, and are thus allowable for at least the

reasons presented above. Claims 23 and 34 includes similar limitations as claim 1, and so the arguments above apply with equal force to these claims.

Claim 2:

In addition to the distinctions noted above in regard to the independent claims, the cited art does not teach or suggest the limitation *wherein the curve is a Low Discrepancy Curve*. The Examiner asserts an equivalence between Davies' object boundaries and Appellants' Low Discrepancy Curve. Appellants respectfully disagree. Appellants submit that Applicant's Low Discrepancy Curve is defined by or based on the generated bounded low discrepancy sequence of points, and that both this sequence and the defined curve are each distinct from Davies' object boundaries in that Davies' object boundaries are geometric surfaces used to test for inclusion of low discrepancy points within the volume defined by the object boundaries, and do *not* include the low discrepancy sequence itself.

Furthermore, the Examiner asserts that Davies' "curvatures can be interpreted as low discrepancy sequences", and thus can read on the language of claim 2. Applicant disagrees. As noted above, Applicant submits that Davies' "curvatures" are *a priori* defined surfaces defining the object's boundaries. More specifically, Davies' object boundaries are not a sequence of bounded low discrepancy points as disclosed and claimed in the present application. As also noted above, Appellants submit that a "curvature" or surface is not a curve. For example, although a surface may have a curvature at each point on the surface, the curvature itself is not a curve. Similarly, although Davies' object surfaces may certainly be said to have curvature, the surfaces are not in themselves curves, and are specifically *not* Low-Discrepancy Curves, as claimed by Appellants. Moreover, nowhere does Davies teach or suggest, or even mention, a Low-Discrepancy Curve at all. Nor does Ninomiya teach or suggest or even mention a Low-Discrepancy Curve. In fact, Ninomiya makes no mention of a curve at all.

Thus, for at least these reasons, Appellants submit that claim 2 is patentably distinct and non-obvious over Davies and Ninomiya, either singly or in combination.

Claims 3, 24, and 35:

In addition to the distinctions noted above in regard to the independent claims, the cited art does not teach or suggest the limitation *scanning the region according to the curve defined by the Low Discrepancy Sequence.* The Examiner asserts that Davies teaches sampling parts of a space utilizing pseudo-randomness defined by low discrepancy sequences, and further asserts that the "sampling" of Davies is functionally equivalent to the "scanning" of Appellants' claims. Appellants respectfully disagree.

As noted above, Davies nowhere describes a curve defined by a Low Discrepancy Sequence. Furthermore, Davies "sampling" of the space refers simply to determining if a generated low-discrepancy point in the space is inside or outside the object. Appellants submit that it is improper to equate Davies' "sampling" to Appellants' *scanning the region according to the curve defined by the Low Discrepancy Sequence*, since scanning refers to making some type of measurement at points along the curve, also known as a motion control trajectory, as described in the Specification on p. 8, lines 17-20, p. 43, lines 5-6, and elsewhere. As Davies makes no measurements, Appellants submit that no scanning operation is disclosed in Davies. Additionally, nowhere does Davies mention or describe a curve defined by the Low Discrepancy Sequence, nor scanning along such a curve, but rather describes computing the Low Discrepancy Sequence, and determining if the points of the sequence themselves fall inside or outside the object boundaries. As noted above, Ninomiya fails to disclose or even mention a curve at all, and also fails to disclose scanning along such a curve.

Thus, Appellants respectfully submit that neither Davies nor Ninomiya, either singly or in combination, teaches or suggests the limitations of claims 3, 24, and 35. Thus, for at least these reasons, Appellants submit that claims 3, 24, and 35 are patentably distinct and non-obvious over Davies and Ninomiya.

Claims 12 and 31:

In addition to the distinctions noted above in regard to the independent claims, the cited art does not teach or suggest the limitation *storing each bounded Low Discrepancy Point of the Low Discrepancy Sequence as it is generated.* Appellants submit that neither Davies nor Ninomiya teaches or discloses *bounded Low Discrepancy Points of the Low Discrepancy Sequence*, as argued at length above. Thus, Appellants respectfully submit that neither Davies nor Ninomiya, either singly or in combination, teaches or suggests the limitations of claims 3 and 24. Thus, for at least these reasons, Appellants submit that claims 3 and 24 are patentably distinct and non-obvious over Davies and Ninomiya.

IX. CLAIMS APPENDIX

The claims on appeal are as follows.

1. A method for generating a curve in a region, the method comprising:

generating an unbounded Low Discrepancy Point;

applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region;

repeating said generating and said applying one or more boundary conditions one or more times, thereby generating a Low Discrepancy Sequence in the region;

storing the Low Discrepancy Sequence; and

generating output comprising the Low Discrepancy Sequence, wherein the Low Discrepancy Sequence defines the curve in the region.

2. The method of claim 1, wherein the curve is a Low Discrepancy Curve.

3. The method of claim 1, further comprising:

scanning the region according to the curve defined by the Low Discrepancy Sequence.

12. The method of claim 1, wherein said storing the Low Discrepancy Sequence comprises:

storing each bounded Low Discrepancy Point of the Low Discrepancy Sequence as it is generated.

23. A memory medium which is operable to store program instructions for generating a curve in a region, wherein said program instructions are executable to perform:

generating an unbounded Low Discrepancy Point;

applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region;

repeating said generating and said applying one or more boundary conditions one or more times, thereby generating a Low Discrepancy Sequence in the region;

storing the Low Discrepancy Sequence; and

generating output comprising the Low Discrepancy Sequence, wherein the Low Discrepancy Sequence defines the curve in the region.

24. The memory medium of claim 23, wherein the programs instructions are further executable to perform:

scanning the region according to the curve defined by the Low Discrepancy Sequence.

31. The memory medium of claim 23, wherein said storing the Low Discrepancy Sequence comprises:

storing each bounded Low Discrepancy Point of the Low Discrepancy Sequence as it is generated.

34. A system for generating a curve in a region, comprising:

a CPU; and

a memory medium which is operable to store one or more software programs;

wherein said CPU is operable to execute said one or more software programs to perform:

generating an unbounded Low Discrepancy Point;

applying one or more boundary conditions to the unbounded Low Discrepancy Point to generate a bounded Low Discrepancy Point, wherein the bounded Low Discrepancy Point is located within the region;

repeating said generating and said applying one or more boundary conditions one or more times, thereby generating a Low Discrepancy Sequence in the region;

storing the Low Discrepancy Sequence; and

generating output comprising the Low Discrepancy Sequence, wherein the Low Discrepancy Sequence defines the curve in the region.

35. The system of claim 34, wherein the CPU is further operable to execute said one or more software programs to perform:

scanning the region according to the curve defined by the Low Discrepancy Sequence.

X. EVIDENCE APPENDIX

No evidence submitted under 37 CFR §§ 1.130, 1.131 or 1.132 or otherwise entered by the Examiner is relied upon in this appeal.

XI. RELATED PROCEEDINGS APPENDIX

There are no related proceedings.